ELECTRICAL CONTACTS AND METHODS OF MANUFACTURE

Background of the Invention

This invention relates to electrical contacts and methods of manufacture

The invention is more particularly concerned with hyperboloid socket contacts and their manufacture.

Hyperboloid socket contacts have a number of resilient wires extending longitudinally of the socket with opposite ends of the wires displaced with respect to one another through a small angle around the circumference of the socket so that the internal diameter of the passage through the wires midway along the length of the socket is reduced. This forms a resilient contact region for a male pin contact inserted in the socket. Opposite ends of the wires are welded to some form of retaining structure. Typically, a socket might have five wires equally spaced from one another around the circumference of the socket. The contacts are usually made by loading individual wires into respective slots in a cylindrical mandrel, the slots extending along the mandrel at an angle. The mandrel holds the wires in position while their ends are welded to some form of retaining structure. Contacts of this kind are described, for example, in US3023789, US3107966, US3470527, US3557428, US3858962 and US5203813. Hyperboloid contacts are sold by Hypertac Limited of London, England, by Hypertronics Inc of Hudson, Mass, USA and by Interconnectron GmbH of Deggendorf, Germany.

Hyperboloid contacts have various advantages over other contacts in that they can have a low contact resistance, a low insertion force, a long effective life, they can carry high currents, they have an excellent wiping action and can be stable under shock and vibration.

Brief Summary of the Invention

It is an object of the present invention to provide an alternative contact and method of manufacture.

According to one aspect of the present invention there is provided an electrical socket having a retaining structure and a plurality of resilient wires extending along the socket in a hyperboloid arrangement and exposed for contact with a male contact member inserted within the socket, the wires being arranged in groups of at least two wires each, and the spacing of the wires in each group being closer than that of the groups from one another.

The wires in each group preferably extend along the socket in contact with one another. The socket may include three groups of two wires each. The wires may be retained in groups by attachment to rings at opposite ends of the socket.

According to another aspect of the present invention there is provided a method of making an electrical socket comprising the steps of loading at least two spring wires into each of a plurality of slots in a mandrel, which slots extend along the mandrel at an angle to its axis, inserting the mandrel with the loaded wires into a retaining structure, attaching opposite ends of the wires to the retaining structure, and removing the mandrel to leave the wires extending along the socket in a hyperboloid arrangement.

The at least two wires are preferably loaded into the respective slots in the mandrel at the same time. The retaining structure may include a ring at opposite ends of the socket to which the wires are attached. The wires may be attached to the retaining structure by welding.

According to a further aspect of the present invention there is provided an electrical socket made by the method of the above other aspect of the invention.

A socket and its method of manufacture, according to the present invention, will now be described, by way of example, with reference to the accompanying drawings.

Brief Description of the Drawings

Figure 1 is a perspective simplified view of a conventional socket having ten wires;

Figure 2 is a side elevation view of a conventional mandrel of the kind used in the manufacture of the socket in Figure 1 but simplified to have only five wires;

Figure 3 is a transverse section along the line III-III of Figure 2;

Figure 4 is a side elevation view of a socket according to the present invention;

Figure 5 is a side elevation view of a mandrel used to make the socket of Figure 4; and

Figure 6 is a transverse cross-section along the line VI-VI of Figure 5.

Detailed Description of the Preferred Embodiment

With reference first to Figure 1, the conventional socket 1 has a number of resilient, metal wires 2 extending along the socket and equally spaced from one another around its circumference. The wires 2 are welded at their ends to respective rings 3 and 4 at opposite ends of the socket 1. The location at which one end of each wire 2 is attached to the forward ring 3 is displaced angularly around the socket from the location at which the opposite end of the wire is attached to the rear ring 4. In this way, the wires 2 have a hyperboloid configuration in which the passage along the socket between the wires reduces in diameter to a minimum midway along the length of the socket. The assembly of the wires 2 and rings 3 and 4 is mounted in a tubular housing (not shown) including some form of terminal to which electrical connection can be made. A male contact 5 inserted in the socket 1 from its forward end makes a sliding contact with the wires 2 in the central region of the socket.

With reference now also to Figures 2 and 3, there is shown a mandrel 10 used in manufacture of the socket 1. The drawing only shows a mandrel for a socket having five wires, for simplicity. The mandrel 10 is in the form of a solid rod of cylindrical shape and circular section. The mandrel has five slots 11 extending along its surface, the slots extending along the length of the mandrel and being inclined at an angle to its axis. The floor of each

slot 11 is flat along its length but, because of the angle of the slots, the depth of each slot varies along the length of the mandrel 10, being a maximum midway along its length and reducing towards opposite ends. The depth of the slots 11 midway along the length of the mandrel 10 is such that the floor of the slots lie on a circle 12 in a transverse plane, the diameter of which is equal to the desired diameter of the passage between the wires 2 midway along the length of the socket. The width of each slot 11 is equal to the diameter of a wire 2.

A socket 1 is manufactured by loading five wires 2 into the mandrel 10, one in each slot 11. The wires 2 are straight and, therefore, lie flat on the floor of the slots 11. The mandrel 10 with the loaded wires 2 is then inserted through the rings 3 and 4 or other retaining structure and the wires are welded to the rings. The mandrel 10 is then removed leaving the wires 2 attached at their ends to the rings 3 and 4 and extending in a hyperboloid arrangement.

With reference to Figure 4, there is shown a socket 20 according to the present invention. The socket 20 is substantially the same as that shown in Figure 1 except that it has six wires 21 to 26 and that these are arranged in three groups of two wires each 21 and 22, 23 and 24 and 25, and 26. The wires 21 to 26 in each group extend side-by-side in contact with one another and the three groups of wires are spaced from one another equally around the circumference of the socket 20. The spacing between the groups of wires is, therefore, greater than the spacing of the two wires in each group.

The socket shown in Figure 4 is made using the mandrel 30 shown in Figures 5 and 6. This mandrel 30 is the same as that shown in Figures 2 and 3 except that it has only three

slots 31 to 33 and that the width of each slot is equal to twice the diameter of the wires 21 to 26. In this way, two wires 21 and 22, 23 and 24, and 25 and 26 are loaded side-by-side into each slot 31 to 33. Preferably, the two wires are loaded into each slot 31 to 33 at the same time. The wires 21 to 26 are welded to the rings 3' and 4' in the same way as conventionally.

This socket and method of manufacture have several advantages over conventional sockets and methods.

First, by loading more than one wire at a time into each socket, the loading cycle time is reduced. The cycle time for loading six wires by the present invention can be 40% less than that for loading five wires individually, in the conventional manner. The loading operation can also be more reliable where there are a reduced number of loading steps, as in the present invention. By grouping two or more wires together it is possible to manufacture a socket having a greater number of wires without increased manufacturing cost. This brings several advantages. For example, where six wires are used according to the present invention compared with five wires previously, the maximum current for the socket is increased by 20% and the contact resistance is reduced by 20%.

It will be appreciated that the invention is not confined to sockets and mandrels having groups of two wires each but could have three or more wires in each group. The number of groups could also be different from the three groups described.